

REMARKS/ARGUMENTS

Claim 1 has been amended to include the limitations of claim 4; support can be found in original claim 4 as filed. Claim 4 has been cancelled without prejudice and disclaimer of subject matter. No new matter has been added.

The amendment to claim 1 includes subject matter that was previously considered by the Examiner. Thus, no new search and consideration issues are raised by the amendment.

Related art rejections

1. The 35 USC § 103(a) rejection of claims 1, 4, 5, 7, 12, 14 and 19 as being unpatentable over JP 2002-042809 ("*Hara*") in view of US 2003/0054249 ("*Yamamoto*") is respectfully traversed.

The Office asserts that *Hara* discloses lithium secondary batteries "comprised of a negative electrode [0013] having a thin film of silicon oxide on the surface of a collector [0016]..."¹ The Office concedes that *Hara* "is silent towards the film being formed by vacuum vapor deposition or sputtering and having a thickness from 0.1 to 50 μm ."² The Office cites *Yamamoto* and asserts that this cited reference "teaches a lithium secondary battery where a silicon oxide film layer is formed by vapor deposition and sputtering for an anode layer [0100, 0101] and the anode layer thickness may be between 30 to 300 microns [0099] which affects the charge-discharge efficiency (Figure 9, 10)."³

First, the teachings of *Hara* and *Yamamoto* are divergent. *Hara* teaches away from the use of carbon as a negative electrode active material: "The maximum charge-and-discharge capacity of the rechargeable battery which used carbonaceous materials, such as black lead, for negative electrode active material is 372 mAh/g, and is small compared with

¹ Office Action at page 2.

² *Id.*

³ *Id.* at page 3.

the case where metal lithium is used."⁴ As a result, *Hara* considers a metal oxide as a candidate for the active material: "the metallic oxide containing the metal which forms lithium and a metal alloy is proposed...and it came to reveal high charge-and-discharge capacity by this as compared with the carbonaceous material."⁵ *Hara* therefore discloses the use of "SiOx as an electrode active material."⁶

On the other hand, *Yamamoto* states that the use of "a material with a larger lithium occlusion capacity as an anode material" such as the *Hara*'s SiOx,⁷ "a capacity itself may be increased. Simply using such a material cannot, however, increase a capacity in a range where a battery is actually used."⁸ *Yamamoto* therefore teaches that materials with a larger lithium occlusion capacity than carbon, such as *Hara*'s SiOx, are unsuitable by themselves for increasing the "capacity in a range where a battery is actually used."

Further, the *Yamamoto* anodes have a carbonaceous material as a main layer: "the anode having a multi-layer structure, comprising: a first layer containing carbon as a main component..."⁹ In discussing the anode embodiment of the invention, *Yamamoto* states that a "carbon anode 2a is an anode member..." where "carbon anode 2a is made of a carbon material capable of occluding Li; for example, graphite, fullerene, carbon nanotube, DLC, amorphous carbon, hard carbon and mixtures thereof."¹⁰ *Yamamoto* therefore discloses the use of carbon as a material for the negative electrode active material, a material which *Hara* teaches away from using as discussed above.

The teachings of the cited references are therefore divergent for the reasons given above. Accordingly, there is no motivation to combine the references.

⁴ *Hara* at paragraph [0003].

⁵ *Id.*, emphasis added.

⁶ *Id.* at paragraph [0004].

⁷ See *Hara* at paragraph [0001] "using the material which can emit [occlusion and] a lithium ion."

⁸ *Yamamoto* at paragraph [0047], emphasis added.

⁹ *Id.* at Abstract, emphasis added.

¹⁰ *Id.* at paragraph [0067].

Furthermore, claim 1 has been amended, supra, to recite "wherein the silicon oxide is SiO_x (0.5 ≤ x ≤ 1.2)" Preferably, "the silicon oxide is SiO_x (0.5 ≤ x < 1.0)" (claim 5).

Applicant has shown that batteries having negative electrodes made of SiO_x exhibit excellent initial efficiencies and initial charge capacity when the claimed negative electrodes are used. The data span the range of 0.5 ≤ x ≤ 1.2 and include the end points (Example 1 to Example 8). Conventional example 1 had a x value of 1.4, thus outside the range as claimed. The comparison between Examples 1-8 and Conventional example 1 is a closer comparison than between the negative electrode as claimed and those allegedly disclosed in the art. Volume expansion of the battery is large when x is less than 0.5, and thus the batteries break down.

The initial efficiencies of the Example 1-8 batteries range from 75 to 85%, and the initial charge capacity is from 0.9 to 1. Conversely, these data for the Conventional example 1 battery are 46% and 0.46, respectively. These results shown in Table 1, reproduced from US 2007/0059601 (the publication of the present application), in part, below:

TABLE 1

| | Film formation material | Average particle diameter (μm) | Negative electrode formation method | Thin film thickness (μm) | Oxygen molar ratio | Initial efficiency (%) | Initial charge capacity | Film formation rate |
|------------------------|-------------------------|--------------------------------|--|--------------------------|--------------------|------------------------|-------------------------|----------------------------|
| Example 1 | SiO sintered compact | 250 | Ion plating | 0.05 | 0.5 | 84 | 1 | |
| Example 2 | SiO sintered compact | 250 | Ion plating | 0.1 | 0.5 | 85 | 1 | |
| Example 3 | SiO sintered compact | 250 | Ion plating | 1 | 0.5 | 85 | 1 | |
| Example 4 | SiO sintered compact | 250 | Ion plating | 20 | 0.5 | 83 | 1 | |
| Example 5 | SiO sintered compact | 250 | Ion plating | 50 | 0.5 | 78 | 0.9 | |
| Example 6 | SiO sintered compact | 250 | Ion plating(*1) | 1 | 0.9 | 81 | 1 | |
| Example 7 | SiO sintered compact | 250 | Vacuum vapor deposition | 1 | 1.2 | 75 | 1 | Slow in resistance heating |
| Example 8 | SiO sintered compact | 250 | Sputtering | 1 | 1.0 | 80 | 1 | Extremely slow |
| Conventional Example 1 | — | — | Powder kneaded, coated, dried processing | 200 | 1.4 | 46 | 0.6 | |

Applicant has therefore demonstrated that the claimed negative electrodes result in unexpected results, in view of the cited references, in regard to (at least) the initial efficiency

and initial charge capacity of batteries that have the claimed negative electrodes. There is no suggestion of this effect in the cited references.

In view of the foregoing, there is no modification to combine the references and Applicant has demonstrated superior results for when the presently claimed anodes are used in batteries. Withdrawal of the rejection is respectfully requested.

2. The rejection of claims 3 and 13 under 35 USC § 103(a) as being unpatentable over *Hara, Yamamoto*, and US 5,755,940 ("*Shindo*") is respectfully traversed for the same reasons given above. *Shindo* contains no disclosure of carbonaceous materials or metallic oxide materials as candidates for a negative electrode active material. Accordingly, *Shindo* fails to remedy the deficiencies of *Yamamoto*, discussed above. Further, *Shindo* does not disclose anything in regard to initial efficiencies and initial charge capacities of batteries.

Withdrawal of the rejection is respectfully requested.

Other matters

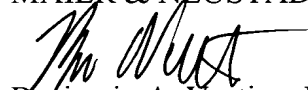
Applicants have complied with the request for a new title. Acknowledgment thereof is respectfully requested.

Conclusion

Applicants respectfully submit that the above-identified application is in condition for allowance. Notification thereof is requested.

Respectfully submitted,

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